levels. The anticyclone has a system of outward components from top to bottom, and the cyclone a system of inward components from bottom to top, but in neither case can there be any true inversion in the type of the system. The temperatures show that the wave motion is intensified on approaching the surface, as the strong eastward drift is gradually diminished in the lower levels. The pressure, on descending from one level to the other, in the same way gradually takes on the well-known features of the high and low pressure areas, the high areas standing with the "saddle" toward the south, and the low areas with the "saddle" toward the north. The *closed* isobars decrease in density from the surface upward, and disappear at two or three miles above the ground, being depleted at the top by penetration into the eastward drift. Whenever closed isobars occur there is a vertical component of the circulation, downward in anticyclones, upward in cyclones. There is evidently very little vertical movement in the upper levels of the atmosphere, where the isobars are mere wavy lines, unless some unobserved closed isobars occur, as is probably the case in the development of hurricanes in the Tropics.

In fig. 10 the disturbing components are given for the velocity, temperature, and pressure. In the velocity of the anticyclone there is a gradual transition of the known outflowing structure at the surface into a simple loop in the upper levels, the orientation being changed only a little; in the cyclone the inflowing components are better preserved from the surface to the higher levels, but there is a distinct rotation of the structure through about one quadrant. The temperatures show the maximum disturbances on the boundary of the high and low areas, with a distinct rotation of both the cold and warm areas through one quadrant. The pressure disturbances consist of closed isobars gradually diminishing into loops in the higher levels and rotating through one quadrant, especially in the cyclone. In one aspect the analytical solution of this dynamic structure is simpler than that demanded in Ferrel's or in Guldberg and Mohn's adopted types of vortices, but it is certainly different from either of them. It is evidently necessary to distinguish carefully between the cyclonic system proper and the resultant system formed by its combination with the general eastward drift, so that the mathematical analysis shall not deal with the components and resultants indiscriminantly. It is not proper to appeal to observed resultant motions in the atmosphere in verification of a theory applying solely to the components, namely, the cyclonic and anticyclonic gyrations as examples of a special form of vortex. Having thus found at least an approximate system of correlated velocities, temperatures, and pressures in the atmosphere, it will be possible to approach the mathematical analysis of the structure with some prospect of a satisfactory solution.

VERTICAL AIR CURRENTS.

By FRANK W. PROCTOR. Dated Fairhaven, Mass., January 28, 1906.

In the MONTHLY WEATHER REVIEW for September, 1905,[1] Mr. Clayton mentions two instances of vertical air currents having considerable lifting power. Both occurred on mountains, and Mr. Clayton expresses the opinion that "it is probable that near the ground over a level country the air can have no great vertical motion, except in whirlwinds, so that phenomena of this kind are not observed."

The writer has observed one case of a descending vertical air current in a valley, which seems to be a precise counterpart of the current that lifted Mr. Eddy's kite vertically about 1000 feet above Blue Hill, as described by Mr. Clayton. It was in summer, and the writer was flying a Hargrave kite of the Weather Bureau pattern, standard size, without any load, at Andover, N. H., in the valley lying between Ragged and Kearsarge mountains. These mountains rise 1400 and 2400 feet, respectively, above the level of the valley floor, which is narrow at this point.

Upward of 2000 feet of wire were out when the line apparently broke, and the kite fell rapidly and disappeared. The line of flight was across a river, and in order to prevent if possible the wire from sagging into the river and getting wet, the line was reeled in as rapidly as possible. With no tension on the wire, and a reel that took in approximately five feet at every turn, the line came in pretty fast. After about 500 feet had been reeled in, the kite was seen to rise, and it was then discovered that the line was not broken, and that the fall of the kite was due to a descending air current.[2]

At another time on a summer day at the same place, this kite, while flying at an ordinary angle, rose and passed the zenith at a height of about 1000 feet, being lifted by a vertical current. There was no cloud overhead.

The writer has several times had toy kites lifted by vertical currents during summer anticyclonic weather, while flying at levels from 100 to 300 feet, over the south shore of Massachusetts, where the ground is tolerably level. From the fact that in the nonenergetic summer areas of high barometer falling currents are rarely seen, while rising currents are not rare, it seems to be a fair inference that at this time of year the slow descent of large masses of air is offset by the more rapid ascent of small masses. These small rising masses are probably too irregular in horizontal section and too evanescent to generate whirls.

SNOW FORMED BY MIXTURE OF WARM AND COLD AIR.

By RICHARD W. GRAY, Assistant Observer, Weather Bureau. Dated Atlantic City, N. J., February 7, 1906.

At Atlantic City, N. J., on February 6, snow, in the form of minute flakes, fell continuously from 10:45 a. m. to 3:30 p. m., the sky during this period being perfectly clear. At intervals, and for periods of from one to two minutes, the flurries were quite heavy, and, except for the size of the snowflakes, had every appearance of an ordinary snowstorm. Condensation seemed to take place at a low altitude (probably not more than 75 or 100 feet above the ground), and had practically ceased at the elevation of ordinary buildings.

The unusual condensation was evidently caused by the mixing of relatively warm and moist air from the ocean with the colder air over the land. The wind, during the occurrence of the phenomenon, was from the northeast; the temperature ranged from 15° to 22°, and the relative humidity averaged about 70 per cent. Strato-cumulus clouds began to form about 3:30 p. m., at which time the snow ceased.

It is generally taught that rain and snow are formed principally by the cooling due to the expansion of rising moist air; still it is also recognized that small amounts of rain or snow can be formed by the cooling due to the radiation of heat during the nighttime, but the quantities formed are small, the process is slow, and the radiation is itself checked by the haze or fog or thin cloud that accumulates, so that the radiation can only take place from the upper surface of a cloud.

Precipitation can also take place by the intimate mixture of warm and cold moist air, and, if the masses and temperatures are properly adjusted, light snow may be formed in this case. It frequently occurs in the winter months that a mass of clear, cold air, moving southward from Canada, encounters a corresponding mass of warm, moist air in the United States, and the pressures and densities are so well adjusted that we have a well-defined band trending east and west, showing gentle southerly winds on the south side, and gentle northerly winds on the north, with a belt of cloudy air separating them, over which light rain or snow occasionally falls. Eventually, some-

[1] Pages 390–91.

[2] Would not a simple failure of the wind have produced the same drop of the kite and wire?—*C. A.*

times after several days, a whirl begins at the westerly end of this band, and the whole system resolves itself into a "low" with its whirling winds.

A close analogy is found between these bands of opposing winds and the case quoted in the preceding note, where cold, moist air from the ocean was flowing inward on the New Jersey coast, while at the same time, according to the weather map, a cold, dry, northwest wind was blowing from the interior over this region. The northeast ocean wind, having a temperature of 15° to 22° F., was mixing with the northwest land wind, having a temperature of about 0° F., judging from the isotherms of the morning weather map, producing the minute snowflakes described by Mr. Gray. It is to be regretted that the exact temperature, moisture, and wind could not have been observed by Mr. Gray, with the help of kites, at various elevations. The layer of northeast wind seems to have extended above the buildings in his neighborhood, but the weather map shows that the dry, cold wind must have been present, probably as a very gentle upper wind from which cold air descended in little streaks, just as we see in an area of high pressure and clear blue sky on a summer day, when air comes down in little gusts, spreading outward as they strike the ground, carrying the dust before them as the wind rolls along the ground.—*C. A.*

PREVENTION OF DAMAGE BY FROST.

By ROBERT P. SKINNER, U. S. Consul General, Marseilles, France. Dated January 25, 1906.

No general attempt is being made in France to prevent the destructive influence of frost in the vine-growing regions. The traditional method of waging warfare against such influences is by creating a dense smoke, caused by burning damp straw, but the process is expensive and of doubtful efficacy. Several proprietary compositions, intended to perform efficiently the work inadequately performed by burning straw, are upon the market, but their sale has been kept back by the low prices which common table wines now bring, so low, indeed, that wine growers would rather see their crop damaged than spend any considerable amount of money to prevent it. Nevertheless many proprietors of advanced ideas, and especially such as produce expensive kinds of wine, are making what seems to be an increasing market for the smoke producing preparations offered for sale. The officers of the best known company in this business inform me that they took hold of the "Fumigène Mortier" about five years ago, and though they have not advertised it publicly, they say that this branch of their very large business is steadily increasing, and that within the last three years they have themselves disposed of 20,000 boxes in France alone. This would mean, in a period of three years, about 2000 hectares (4942 acres) treated. In 1903, 1500 boxes were sold by the same company in Smyrna, after which the Turkish Government put a stop to the importation, on the ground that the boxes contained nitrate of potash. I have no knowledge in regard to the commercial success of other devices, all of which appear to have been subjected to numerous tests in the presence of official and semiofficial committees.

From the account of one such test, which took place on May 21, 1900, near Auxerre, in charge of M. Méras, Director of the Society for the Reconstitution of French Vineyards, I take the following paragraphs:

> The experiments took place with different systems, industrial and natural, permitting the production of artificial clouds, which in their turn prevent the radiation which causes frost, and thereby prevent the killing of the buds. Let us first explain how frost is produced by radiation.
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> Dew is deposited on a body when the latter, having allowed to escape during the night a portion of the solar heat received during the day, becomes so chilled by radiation as to lower the temperature of the adjacent air, and bring about a state of saturation. From that instant, if the air continues to become colder, the vapor which it contained is condensed in the form of dew. A white frost is produced when the temperature of the bodies on the surface of which the dew is formed is low enough to cause the dew to congeal. When a body is sheltered by cloths, straw-matting or natural clouds, the deposit of surface dew is light. As the radiation takes place in every direction, the heat radiated from the surface is reflected back by the shelter, whereby the chilling process is not sufficiently pronounced to result in a white frost.
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> M. Méras proceeded to the successive lighting of the different combustibles prepared for the purpose of forming clouds. He first experimented with pots containing exactly 7.5 kilograms (16.5 pounds) of coal tar, this weight corresponding to those of the boxes bearing the names of Maydieu and Lestout, both manufactured at Bordeaux, and the "Fumigène Mortier," manufactured at Marseilles. The smoke produced by the coal tar proved to be black, and formed a screen less able to prevent radiation than that produced by a white smoke. The intensity of the smoke was increased by sprinkling water upon the tar by means of a broom. The first composition burned two hours, and it was judged that the boxes, placed at distances of 20 meters (65.61 feet) from each other, should have been separated by not more than 10 meters (32.80 feet). The fact that the buds appeared to be blackened after this operation need alarm no one, as this blacking is due simply to the deposit of soot. After these experiments with coal tar, the industrial preparations were taken up.
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> The Lestout composition consisted of a square pine box, containing 7.5 kilograms (16.5 pounds) of residue from the manufacture of rosin. The boxes cost 1 franc (19.3 cents) each. The smoke, as black as in the first case, appeared to be heavier and rose less than that of burning tar. The period of combustion was one hour and a half. These boxes have the inconvenience of taking fire, and by their disaggregation they thus allow the contents to escape and burn upon a considerable surface, thus abridging the duration of the protecting cloud.
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> The Maydieu box was next lighted, and gave the same results as the Lestout box, except that the period of combustion was longer. In both cases the intensity of the smoke is susceptible of being increased by covering the boxes with moss or dampened straw.
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> The commission next experimented with boxes of dampened sawdust, mixed with bunches of green moss, straw manure, and damp straw. It required a considerable time to start the fires; but although these boxes gave a whiter smoke, it proved to be insufficiently dense to be really efficacious. By dosing the mixture with tar a more abundant smoke was obtained. These natural combinations, which are economical enough, have the disadvantage of proving useless in case of an abundant rain falling upon them during the night or even several days prior to the period of use. Small proprietors, however, who wish to avoid expense, may utilize them.
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> The commission finally took up the newly invented preparation known as the "Fumigène Mortier" from Marseilles. This preparation was packed in boxes containing about 4 kilograms (8.8 pounds) of black powder, the boxes selling at 1.50 francs (29 cents) each. In the middle of the cover of the box a hole is made before the "Fumigène" is put in place. When the time comes to produce the smoke, the material is lighted from this hole, whereupon the box is turned over with the hole upon the earth. This being done by the commission, a very intense and very abundant smoke was immediately produced. This yellowish smoke formed a veritable cloud, constituting a powerful screen over the vineyard to be protected. This smoke remained in place longer than any smoke previously produced, in spite of a fairly strong wind. Had there been no wind, and there is none when frosts occur, it is certain that this smoke would remain in place long enough to prevent any white frost. According to the opinion of all present, the "Fumigène Mortier" gave the best results.

Since the original experiments were made along these lines the manufacturers claim to have perfected the composition, and they suggest an elaborate system of electrical wires connecting various parts of large estates with headquarters in such manner that when registering thermometers, set up in the vineyards, fall to the danger point, an alarm bell rings in headquarters, whereupon the overseer arouses his employees, and starts the protecting fires. M. Justin Lieutaud, of the Mas de l'Ange, Camargue, possesses such an installation, which protects 30 hectares (74.13 acres). My information in regard to M. Justin Lieutaud's equipment is dated five years ago, and I have no information in regard to his experience since.

It is to be remarked that frost-fighting methods are still in an uncertain and tentative stage. Reports in regard thereto, as well as in regard to efforts to counteract the processes of nature concerning rain and hail, are accepted with skepticism, and I do not myself wish to be considered as indorsing any process described. On the other hand so much is claimed, and the materials spoken of are so cheap, that American farmers can readily take the matter up on their own account.